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ABSTRACT

The author has prepared a group of questions which he feels are of great importance in deciding the future of instructional technology in education. He provides some insights into possible answers as well. The questions he asks and answers deal with educational philosophy, the science of learning and communication, educational technology, and educational media. He defines educational technology as a four-part process, comprising the formulation of objectives, identification of types of learning, manipulation of conditions of learning, and measurement techniques. After a discussion of each of these four parts he examines the field of media organization in an attempt to find a way to implement education technology and solve the problems of production, storage, and utilization. (JY)

A Framework for Studying Instructional Technology

by Richard Hooper*

WHERE IS THE BEGINNING?

The strength of educational technology will depend ultimately on the quality of the educational philosophy and the validity of the science of learning that undergird it. A study of "instructional television and radio . . . and their relationship to each other and to instructional materials such as videotapes, films, discs, computers, and other educational materials or devices"** cannot begin with discussions of machinery. The study must start with the totality, and not any specialized parts. There seems to be an increasingly powerful consensus amongst thinkers in many different, and previously unconnected, areas of life that any really basic advance in the future will come as a result of global rather than separatist patterns of thought. Whether it be the regional planners, the conservationists' concern about ecology, Mc Namara in the Defense Department, Michael Harrington talking about the war against poverty, John Cage on contemporary music, the trend is towards the comprehensive approach and away from the piecemeal.

The complexity of the comprehensive approach must be acknowledged at the outset. It is easy to use words such as "multi-levelled", "multi-faceted", "multi-phasic", and extremely difficult to use the thought processes they are trying to describe. A study of educational technology that is to be truly dynamic cannot shy away from the web of interrelationships which make up the educational process. Curriculum development, teacher training, school architecture, selection of textbooks, production of television lessons, scheduling arrangements, budgeting techniques are

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* Richard Hooper was on leave of absence from the British Broadcasting Company as a Harkness Fellow spending two years studying the state of educational technology in the United States when this paper was prepared (May 1968).

** Title III of the Public Broadcasting Act of 1967.

intimately connected despite national associations, jargon, and the traditional piecemeal thinking that have for years kept them apart. The Carnegie Commission on Educational Television emphasized this when it said: ". . . instructional television must be studied in the full context of education. . . ." (emphasis supplied). The finest plans for instructional television and radio will still founder if colleges of education across the USA continue to pay the most minimal attention to these media.

The instructional television producer daily makes decisions which involve -- however unconsciously -- educational philosophy and the science of human learning. If his program turns out to be effective, he will probably attribute its success to "good intuition." Unfortunately, good intuition is a rare commodity. There is an analogy here with teacher training. Educational reformers talk nonstop about the need for more good teachers, but are unable to describe the processes by which a teacher is good. Therefore, it is difficult to replicate them. The problem is not with the good teachers. But how do you consciously influence the teaching techniques of the majority whose intuition is not so good? The science of learning has to begin where the art of teaching and communication -- unfortunately -- ends.

It is difficult to treat educational philosophy and the science of learning separately. They interact on each other the whole time. Increased research into the nature of creativity has led to increased emphasis on fostering creativity in school. Evidence about the importance

of different thought processes has led to educational objectives being made less content-oriented. Educational philosophy is, in simple terms, the what of education: what is education for, what should students learn, what sort of adults should they become, what sort of society are we building? The science of learning is the how: how do people learn, how do we organize the classroom to attain optimal learning, how do people think, how does the presence of color influence learning by television? Most people would agree that what students learn is how to think!

Educational technology's success will be in direct proportion to the amount of attention it pays to the whats and hows of education. The educational film-maker who says "Don't bore me with discussion of educational objectives" is putting his long-term head in the long-term sand. On a slightly different level, too many people working in schools broadcasting dismiss any responsibility for educational philosophy.

WHATS FIRST

Education is notorious for stating its goals in vague and ambiguous terms. This seems an unsatisfactory environment for educational technology

to operate in, and would account for much of its failure to date. If there are no reasonably clear-cut objectives, selection of one medium over another is arbitrary and worthwhile measurement is impossible. One of the great roles that the newer media can play is that of a catalyst. Instructional television can demand a statement of whats because, unlike the textbook, it is a newcomer. It is breaking fresh into the circle (often vicious) of curriculum development. It is not yet locked into the cycle.

The whats of education come in all shapes and sizes. There are significant questions to be asked about rural poverty, college student unrest, the small Negro colleges, drop-out statistics, the "psychological" drop-outs, continuing professional education for doctors, adult training and retraining programs, the finances of private colleges, quality and equality in the inner city, massive surge in student population, massive growth in information, the credibility gap between the world of the classroom and the world outside, the new industrial revolution of computers, automation, and leisure. Before technology rushes off to help individualize the whole curriculum we must ask: doesn't a technological society of such complexity require a redefinition of the individual as he works more and more in teams? These questions must preface any in-depth study of educational technology. Otherwise, after much labor and many almighty dollars, we discover we have not been asking the right questions. How does it affect our conventional telelessons on Silas Marner and Mill on the Floss if we know that the average child watching them will by the age of 18 have spent more time

in front of the television and in the movies than any other single activity (including going to school itself!) except sleeping? What relevance have detailed behavorial specifications in an American History course 1776-1861 to students who are burning the building down?

These questions must not just preface a study of educational technology. It is easy to pay lip service to rural poverty at the beginning, and end up installing instructional television in the prosperous white suburbs (which probably don't really want it). Educational technology will only come to mean anything if it identifies and then gets involved with real educational needs. Harvard and Stanford are not the places to implement educational technology. They do not think they have that sort of problem. But what about the small colleges away from major population centers? What about the decentralized campuses of state universities and junior colleges?

Far too much of educational technology, such as television, has in the past avoided the main educational problem areas. How many ETV stations have done anything for the inner-city kids? The main aim (often unconscious) of instructional television staffs has been simply to get television used. How many sets do you have? How many programs do your children watch? Will you continue membership in the school television service next year? No further questions. In 1963 Dr. C. R. Carpenter of Pennsylvania State University estimated that only about one percent of the total formal educational activity in the United States involves in any way the use of the newer media.[1/] A portion of the blame for the miserable failure must be

attributed to this media nationalism which causes television to ask the wrong questions.

It seems clear that if education -- and therefore educational technology -- does not make a real effort to identify the whats first, then American society will continue to be torn apart by Watts first.

WHICH WAY IS WEST?

The Carnegie Commission stated: ". . . further major investments in instructional television must benefit from the discovery of ways in which television can best contribute to the educational process." The word "process" implies change, movement. The second question, following the whats, must be: how is education proceeding? In which directions is it developing?

There seem to be two major educational wagon trails. What is not so clear is whether they are both leading westwards, or in opposite directions. The first trail could be labeled Unstructured and pioneering names along the way might be A. S. Neill, Jerome Bruner, Paul Goodman, R. F. Mackenzie in Scotland,[2/] John Holt. The second trail -- Structured -- has people like Skinner, Pressey, Ofiesh, and Lloyd Homme.

UNSTRUCTURED	STRUCTURED
Education is internal growth, discovery, and development without fixed goals in a changing and changeable environment.	Education is change from less desirable to more desirable behavior, which is fixed in advance and is externally measurable.
1st step -- questioning whether education should be goal-oriented at all. Here the student is more likely to define his own objectives with adult assistance. Non-predictive, "discovery" type of learning.	1st step -- definition of objective behavioral goals. Adult fixes objectives and, by controlling environment, tries to predict behavior.
Move away from exams and measurement altogether.	Measurement (objective if possible) to see whether student has reached agreed-on performance level.
Openendedness, diversity, problem-finding.	Clearcut endedness, definition, problem-solving.
Students select amongst wide range of different materials (if only because we do not know enough about learning).	Materials and sequence pre-selected for students (we know enough about human learning to control conditions).
Students manipulate and change environment.	Students work inside fixed environments.
More self-direction, more freedom.	More external control of behavior and conditions of learning.
"Education."	Training.

This dualism may turn out to be false when, and if, the conflicting camps ever get to talking to each other. I am beginning to think it is not so much a matter of opposing strategies as of different points along a continuum stretching from TOTAL FREEDOM to TOTAL CONTROL. The exact point on the continuum depends on such things as the particular student, the type and training of the teacher, the nature of the educational materials available, the specific subject

matter or skill to be taught, degree of parental and legislative intervention. Clearly A. S. Neill's Summerhill would be hard to justify in an underdeveloped country which has immediate specific manpower needs. On the other hand, training people to rather narrow specifications may be just as dangerous in an advanced technological society like the USA.

There are other trends in education where there is perhaps more consensus. Identification of these is important if educational technology is going to jump on the right bandwagon. Clearly, broadcast television and radio for schools have some awkward questions to face if the move towards nongraded, individualized systems continues. Must instructional broadcasting is firmly based on lock-step group-prescribed lessons. At the moment the move away from this traditional means of organizing education is mainly at elementary level, but it is spreading upwards. The following trends can be identified:

FROM	TO
Group-paced and group-prescribed instruction for all subjects.	Individually paced and individually prescribed instruction for certain subjects, e.g. math, reading.
30-to-a-class graded schools.	1-5-20-100 to a group in nongraded, continuous-progress schools.
900 sq. ft. egg-box classrooms with poor acoustics.	Flexible areas of learning, clusters of space, acoustic treatment.
Scheduling 40 minute periods, musical chairs.	Modular scheduling, self-scheduling flexibility of time.

FROM	TO
Teacher as presenter of information.	Teacher as manager of classroom, consultant/ tutor, diagnostician.
Emphasis on teaching.	Emphasis on learning.
Teacher/textbook/chalkboard do 99 percent of all information-transmission.	Wider range of media allowed in the classroom-- including films, television and radio, discs and audiotapes, games.
Learning information; emphasis on facts/memory.	Applying information; emphasis on thinking skills.
Passive learning and regurgitation predigested conclusions and secondary source material.	Active learning and participation; inquiry/discovery and primary source material.
Book libraries and film libraries.	Instructional resource centers serving both teachers and students.
Categorization by subject-matter disciplines.	"Seamless web of learning" (Whitehead).
Education ends at 18/22.	Education -- a lifelong process.

Although most people would generally agree that these trends exist, there is disagreement as to how much the newer ideas have been implemented (as opposed to just talked about), and also as to how these newer ideas should be implemented. Terms like "media," individualization," "nongraded" have not settled down into any consistent meaning.

Trickling into these currents of educational movement in a haphazard way are odd bits of data welling up from basic research. A study of educational technology must take this basic research into consideration.

The links between researchers and the teachers and television producers need strengthening if the science of learning is ever to get out of the laboratory. The basic research into learning and into audio-visual communication[3/] should be treated with the same amount of seriousness that medical research is used to. Advances in medicine have not come about because of good doctors alone. They have occurred as a result of the painstaking accumulation of valid data about the human organism. Medicine is made up of three components -- doctors (some of them good), hospitals and machinery, and a fund of scientific principles which guide the behavior of the doctors and the design of the hospitals/machinery. In education the third component is more often than not missing. It is replaced by hunches disguised as substantiated theory, and by something loosely called experience. Hunches and experience are vital to the doctor, but he has more formal supports as well. It is clear that educational technology, of all things, cannot progress very far without that third component.

A MATTER OF DEFINITION

Concern with philosophy and science does not end here, but at this point goes underground, to pop up again continually throughout the study. It must serve as a backdrop for any endeavors concerned with educational technology. This entails the sort of "multi-levelled" thinking mentioned at the start, the sort of thinking which après McLuhan is difficult to express at all satisfactorily in linear-sequential one-word-after-another typewriter print.

An important first step in discussing educational technology itself is definition. What do we mean by it? The subject is surrounded by great semantic confusion. There is, of course, a danger of being too dogmatic at such an early stage. If the definition is too tight, it may inhibit further discovery.

To limit the definition of educational technology to machinery -- e.g., films, coaxial cable, teaching machines, antennae -- would make the task easier. But a study using this definition would quickly find itself up a blind alley. It would lead to the kind of infertile questions which were found in the original Title III draft of the Public Broadcasting Act, such as "the advantages and disadvantages of closed-circuit television." Educational technology must essentially be an idea of which a closed-circuit TV system is one (but not the only) concrete example. Fascination with the tangible machine to the exclusion of the intangible idea behind the machine has in fact led to stereotyped and impoverished uses of television and to a race of gadgeteers disguised as educational technologists.

The essence of television is not x monitors, y image orthicons, z feet of cable. Television is the capability of transmitting live or recorded, over distances ranging from a few yards to thousands of miles, chunks of reality in sound and vision. It is the instant replay of what happened ten seconds ago. It is instant distribution, to an infinite number of places and an infinite number of people, of the same event. It is the computer's mouthpiece, an extension of the police, a modern version of the psychiatrist's couch, and an electronic bathroom mirror for the student teacher.

Much of the trouble with instructional television is that it has taken over all the paraphernalia of commercial and public television without stopping to think. Educational technology is not a thing. John Diebold, a most persuasive illuminator of modern cybernetic society, makes the same point in relation to automation: ". . . Automation. . . implies a basic change in our attitude towards the manner of performing work. Perhaps because we see things more easily than ideas, this meaning of automation as a way of thinking has been obscured by a fascination with the machines of automation. . . Automation is more than a series of new machines and more basic than any particular hardware. It is a way of thinking as much as it is a way of doing. It is a new way of organizing and analyzing production, a concern with the production process as a system, and a consideration of each element as part of the system."[4/]

We could plagiarize John Diebold to get a useful working definition of educational technology:

> Educational technology is a way of thinking as much as it is a way of doing. It is a new way of organizing and analyzing education, a concern with the education process as a system, and a consideration of each element as part of the system.

ALL MEDIA ARE EQUAL. . .

Some of the main elements that make up this sytem need identifying. The ones most relevant to this study are the media by which information transmission takes place and the student interacts with the subject matter. The traditional media for these tasks are the teacher and the textbook.

It is vital that a study of educational technology does not engage in media apartheid, treating some media to the exclusion of others. There are obvious pressures to avoid the teacher and textbook media when discussing television. But they are intimately connected.

Just because in the past textbook selection procedures have been cut off from selection of relevant audio-visual media, there is no need to continue this irrational fragmentation. It is either all or nothing, and the categorizations such as "newer media," "electronic media," "self-instructional media," "nonprint media" have only limited uses. Otherwise the study of educational technology will only serve to prolong the basic tenet of today's classroom: "All media are equal, but some media are more equal than others." By perpetuating this deeply entrenched attitude the study would be in the ironical position of tightening the noose around educational technology's neck.

It would be useful to compile a list of available educational media. Just putting them altogether will help the cause of media equality. Such a list reveals the rich resources which more and more classrooms can call on:

TEACHER	Teacher/tutor (1-2 students) Teacher/seminar (8-10) Teacher/class (30-35) Teacher/lecture (40 upwards) Teacher/multi-media le ure hall
PRINT	Textbook workbook programmed text Reference books Library (traditional)

VISION

- Television
  - open-circuit
    - local/regional
    - national
  - closed-circuit
    - one-room system
    - more than one room
  - dial access/video
  - Electronic Video Recording (CBS, coming soon)
- Film
  - 16mm
  - 8 mm single concept
    - with sound
    - without sound
- Filmstrip
- Slides
  - slide/tape
- Overhead transparencies
- Opaque projector
- Chalkboard
- Stills, charts
- Maps

SOUND

- Radio
  - two-way radio
  - educasting radio
  - sub carrier authorization
  - radiovision (radio + filmstrip, very popular with BBC schools radio)
- Telephone
  - telelecture
  - telelecture with electronic blackboard
- Audiotape
  - language laboratory
  - self-instructional multi-media laboratory
- Phonograph discs
- Dial access/audio

TEACHING MACHINES

Teaching machines (not computerized)
Computer-assisted instruction
teletype
teletype/audio/video

THREE DIMENSIONAL EQUIPMENT

Laboratory equipment
3-D manipulative materials, toys
Educational games, e.g., EDC's social studies game Empire
Simulation equipment, e.g., Navy's Anti-submarine Warfare Attack Trainer

OUTSIDE CLASSROOM

Field trips
museums
historical sites
nature sites
Correspondence courses

Is this sort of list useful? If so, how can it be developed so that more of the known characteristics of each medium come out? Four types of data could begin to be collected for each medium:

(1) Logistical

Questions of cost, ease of accessibility and use. Technical limitations. Availability of software, libraries, etc.

(2) Message characteristics

What sensory modes? Television -- auditory/visual
3-D materials -- tactile/visual/olfactory
Simulation equipment -- kinaesthetic, etc.

Modes of representation
Radio -- verbal, nonverbal sounds
Textbook -- verbal, print, still photos, maps

Feedback characteristics, branching potential, response modes

What new capabilities does it give teacher/student?

What are peculiar qualities of medium? How does it influence content?

(3) Attitudes towards medium -- Faculty, administration, students

(4) Research data on effectiveness

No comprehensive data are available for any medium. Much that could be said about television would have to be subjective. But it might serve as a useful superstructure on which to build in the future. Evidence of costs and technical limitations would be useful immediately. For example, despite some ardent claims, there are limitations on what CAI can and cannot do at the moment. It is important when discussing media characteristics to draw a careful line between what is now possible and what is only potential. This line has been glossed over by dial-access enthusiasts. They use words like "random" which are misleading. In fact, students can have random access to only those tapes which have been set up on the hundred or so channels available, and even then they may come into a program half-way through. The present high cost of true random access makes its introduction seem remote(as with random access for computerized information retrieval).

These media and various combinations of them are the building blocks which can be manipulated by the educational technologist. Educational technology is the orchestration of available classroom media through the dimensions of time/space/dollars to achieve agreed-on objectives with a given student population.

MEDIA ORCHESTRATION

If educational technology is a way of thinking about education, that way of thinking should be valid and useful in the analysis of any size unit

from the events in one 45-minute period, the design of a closed-circuit system, to the full operation of a university. This way of thinking should be valid and useful to a system which has little extra money and no great inventory of equipment. It should be able to provide creative answers for a distraught teacher who wants help now and cannot wait until the system is comprehensively reformed. It should lead to the fullest exploitation of television equipment that has already been purchased, whether or not new equipment can be added. It should be valid in the analysis of procedures in both the Structured and Unstructured systems.

Educational technology has four main components. The words "stages" and "steps" might be best avoided because the process is not strictly sequential:

Objectives formulation

Identification of types of learning involved

Manipulation of conditions of learning

Measurement

* * *

OBJECTIVES FORMULATION

Question A: Who should select educational objectives?

The answer to this -- which is too often taken for granted -- will vastly influence the rest of the process. In the more Unstructured system the students will play an important part right here. "We cannot have real learning in school," writes John Holt in How Children Fail (page 179), "if

we think it is our duty and our right to tell children what they must learn. We cannot know, at any moment, what particular bit of knowledge or understanding a child needs most, will most strengthen and best fit his model of reality. Only he can do this. He may not do it very well, but he can do it a hundred times better than we can. The most we can do is try to help by letting him know roughly what is available and where he can look for it. Choosing what he wants to learn and what he does not is something he must do for himself."

The question of who selects objectives is equally vital in the production of a television lesson. At present, for example at Hagerstown, the television professional is thoroughly subordinate to the educator -- usually a classroom teacher with minimal experience of the medium who has been chosen as TV teacher by other educators on the basis of classroom abilities. The result is Big Talking Face and a use of television to do what was already being done in the classroom. This is undeniably part of television's role but the medium should also open up new paths, not just retrace familiar ones. If it is agreed that the media of television and radio have special qualities and that it takes experience to feel them (it is much more than just an intellectual/conscious process), then there must be more equality at this point. Too often the television people are consulted <u>after</u> the major decisions have been made by highly print-oriented people who are unaware of their biases.

The medium <u>affects</u> the message and this is often forgotten in curriculum development. Too often, especially from the new "systems analysts" of education, the design of conditions of learning is overly

sequential. First you define objectives and then you select the right media. This is a neat arrangement but, like so many neat arrangements, it is oversimplified. Form and content -- as we know from poetry -- cannot be so easily separated. This sort of thinking leads Hagerstown to state: "Television is a conveyor of ideas, not a creator."[5/] Thus the creativity of the newer media is gently syringed out, and the members of the inner sanctuary continue to refuse entry to television and film people while the important objectives are being formulated.

Question B: Should there by objectives at all?

The all too easily accepted assumption "You must first state your objectives" must itself be scrutinized. Lack of objectives may turn out to be very fruitful in certain areas, despite what behaviorists say. It may actually inhibit a lot of art, literary appreciation, younger children's play to demand detailed objectives. These detailed objectives will be very useful when the student has decided he really does want to learn to speak Spanish. Marshall McLuhan points to this problem with objectives in an anecdote: "When people approached T. S. Eliot and said: 'Mr. Eliot, when you were writing "Sweeney among the Nightingales" in that passage XYZ did you mean. . .' he would wait patiently and say, 'Yes. I must have meant that, if that's what you got out of it.' "[6/]

One of the problems that television and radio in education encounter is attracting creative people. Too often creative directors are confronted with lists of objectives and curriculum committees, also demands that they have a teaching certificate and/or Ph.D in mass

communications which may be irrelevant qualifications. By the time the list of objectives has been read out, they have probably left. It is worrying to think that imaginative television people get more freedom (not just financial) on Madison Avenue than they do in instructional television. Education -- and educational technology -- should be BIG enough to say to a radio wizard: "We want some ten-fifteen minute programs on Imagination for 10, 11 year olds," and leave him to it. The greatest works of art -- in any medium -- are those where each member of the audience comes away with something different.

Question C: What input data should be collected to assist in formulation of objectives?

Objectives are radically influenced by the kind of people who select them. They are equally affected by the amount and quality of the data that is collected and fed into the discussion. Too many of the variables which make up the conditions of learning are treated as constants and thus are not even questioned when objectives are being formulated. Which data are relevant depends upon the subject under analysis:

Category I	STUDENTS	Number; age; individual differences; prior knowledge; styles of learning; motivation; pace; interests; reading level.
	INSTRUCTIONAL MEDIA	
		Teachers: number; competencies and experience; attitudes to change; costs per teaching hour.
		Textbooks; availability of xerox copier; projectors; availability of films, slides, tapes; number of television monitors; museum proximity; costs.

SPACE	Number and size of classrooms, lecture halls; library space, carrels; number of power points; acoustics; lighting arrangements; costs of space usage.
TIME	Maximum and minimum time available.
DOLLARS	Any spare dollars not tied up in buildings, teacher salaries.

Category II SOCIETY'S, INSTITUTION'S OBJECTIVES

LEGISLATIVE COMMITMENTS

Local state history, for example

MANPOWER NEEDS OF NATION

REQUIREMENTS OF TECHNOLOGICAL SOCIETY

SUBJECT MATTER

Structure of the disciplines (Bruner); old or new math; relationship between discipline as taught and discipline as practiced outside: analysis of engineers, historians, doctors to identify possible objectives; content or process approach.

LEARNING THEORIES

Assistance with correct sequencing of objectives; analysis of creativity in engineers.

Note: Category II will be more important during objectives formulation, whereas Category I's importance lies more with the design of instructional strategies (see below).

Most analyses of education are suboptimizations. "Analyses. . . confined to lower level contexts, which assume decisions given at higher and collateral levels, are called 'suboptimizations'. They attempt to find optimal (or near optimal) solutions, but to sub-problems rather than to the whole problem of the organization in whose welfare or utility we are interested. If a consumer tries to solve his transportation problem

(Cadillac v. Chevrolet) more or less in isolation, taking other major decisions affecting his income and expenditure as given, he is sub-optimizing."[7/] The art teacher who wants to reform her procedures within the three 40-minute periods she has each week with class x is suboptimizing. The television producer is suboptimizing when he is given the task of producing thirty 20-minute lessons on Climate to go with y textbook.

The aim should be to take as much input data into consideration and as few "assumed decisions" as possible. Clearly the more input data and the less assumed decisions, the nearer you are to dealing with the totality of the system, and vice versa. How often can the television producer ask: why thirty lessons? Why twenty minutes long? Why this particular bit of geography? Why this textbook? And even, why television? Schools television and radio are faced with the eternal problem of "not alienating the system," but as much as possible they should try and question assumed decisions taken at higher and collateral levels. Without this relentless questioning, television will continue to talk off the point and be used on the periphery.

The collection and organization <u>in manipulable form</u> of all relevant input data for a given set of objectives is a major task for the educational technologist. The high-speed data-processing capabilities of the computer will come to the rescue as input data from major systems such as school districts comes flooding in.

Question D: What constitutes a 'good' objective?

There is no one criterion for judging objectives. It depends on the orientation of the people involved (more, or less, behaviorist), and most important on the subject matter. A good objective in the training of hard-core unemployed many differ greatly from a good objective in college-level physics. Possible criteria for judging the value of objectives are: degree of objectivity and measurability; degree to which it does not state the "means" by which the objective will be reached; degree to which its attainment is administerable; degree to which it does not select content; degree to which it stresses the intellectual skills and processes in relation to content; degree to which it is not a test item; degree to which it tells the student what he has to perform, under what conditions, and with what criterion of acceptable performance; degree to which objectives are sequenced in valid hierarchies and taxonomies; degree to which objectives have been externally validated (x behavior desired in medical course relating to x behavior displayed by successful practising doctor).

The development of techniques which can accelerate the formulation of good objectives is another major task for the educational technologist. Present procedures with behaviorial objectives are time-consuming, thus arousing much faculty antipathy.

* * *

IDENTIFICATION OF TYPES OF LEARNING INVOLVED

This component of educational technology is still closer to the researcher's laboratory than to the classroom or television control room. Given the objectives, what types of learning do they involve? Robert Gagnè has described eight types in his well-known book The Conditions of Learning: signal learning; stimulus-response learning; chaining; verbal association; multiple discrimination; concepts; principles; problem-solving. Gagnè stresses the provisional nature of this list and is sure that there exist higher-order cognitive processes which have not yet been identified. Knowledge of the types of learning should feed directly inco the manipulation of the conditions of learning.

* * *

MANIPULATION OF CONDITIONS OF LEARNING

Question A: What are the constraints within which strategies must be devised to reach the objectives?

This makes use again of the input data already collected (specifically Category I) and also the more detailed lists of media characteristics discussed on pp. 13-16. The formula for the actual manipulation looks like this:

STUDENTS

interacting with

SUBJECT MATTER

transmitted by

INSTRUCTIONAL MEDIA

in various combinations, dictated by:

SPACE

+

TIME

+

DOLLARS

+

TYPES OF LEARNING IDENTIFIED

This formula could, for example, lead the producer of a series of telelessons in a school district closed-circuit system to ask the following questions:

STUDENTS — How many? What previous knowledge? Age and grade? Any common features, e.g., motivation level, academic/nonacademic?

SUBJECT MATTER — Which content to select? Does the content dovetail with objectives? What additional content could be introduced to heighten interest and broaden relevance? Does the presentation of content require more than just factual recall and recognition?

INSTRUCTIONAL MEDIA — What media are available?

Closed circuit television: Is there a TV course already produced that might be suitable? Live or recorded? Studio or classroom origination? What opportunity for student participation during lesson? Provision of work-sheets to accompany lesson? Who should present lesson? What films, slides, stills are available/can be made? What music/sound effects? How should lesson end? What is role of television in relation to:

Classroom teachers: What preparation before lesson suggested? Follow-up activities? What content/skills will teachers handle which television does not? What visuals do teachers have to reinforce visuals in telelessons?

Textbook: What information does the textbook carry? Is it to be duplicated by television? Is it basically for reference and independent study? What visuals from book can be used in television lessons?

TIME — How much time is allotted to course overall? How much should be via classroom teachers, television, independent study? Is more time available? What about scheduling problems, repeat broadcasts? Has teacher time for previews?

SPACE — Should telelessons be watched in large group? In classroom groups? If in large group, how much teacher time is saved? Could some of the classroom follow-up be done in large-group lecture? Could some of classroom work be reinforced with independent study? If so, what are facilities for independent study? Is there space in instructional resources center for student review of videotapes?

DOLLARS — Are there any loose dollars? If so, could they pay for a set of overheads for classroom teachers? Can dollars be saved via large-group lecture/independent study? How efficient is space usage? What is cost of finding films and stills already produced, versus cost of producing them?

This type of thinking may not reveal anything very helpful. But it can be a useful device for getting people to see the wider implications and possibilities. It will help to get better mileage out of available

resources. Many of the questions may not have answers, but this in itself will suggest further courses of action. This sort of questioning might in a small way stop television systems from sliding into ruts without realizing it. Time, space, teachers, television are called variables. They should vary.

Question B: Who should manipulate the conditions of learning?

This is as important as who selects educational objectives. In many places the same group do both. Where this is not the case, it is necessary to ensure that the collection of input data is not duplicated. From the Structured point of view the manipulation is done by the behavioral technologist. The John Holts would give much more power to the students themselves.

One of the real problems here is that students do seem to learn in different ways. It is probably only economics and tradition that make us think there is one solution for all the class. There is evidence that some students learn better from books, other from tapes; some are more methodical, others more intuitive. The John Holts are saying that, because of these individual differences, the best guide is the student himself. He will tend to gravitate, given a diverse enough environment, to the means that best suit him. The cafeteria studies with young children seem to support this. Given a varied diet to choose from and complete freedom, young children end up eating a good balance even though they may eat nothing but ice cream for two days! The great challenge to

the new media in the Unstructured system is to make this diversity and richness possible. Books and live teachers cannot do it alone.

Under whatever system, the question of who manipulates the instructional strategies is very important for television. Television people must identify these manipulators and get with them. It affects the whole nature of their power to create, rather than just follow instructions. If television is to mean anything in education, its creators must be amongst the doctors writing the prescriptions, and not -- as happens with audio-visual people -- remain with the pharmacists filling those prescriptions. Television people do not question enough their role of service agency. Technology -- whether it likes it or not -- must struggle for power in education. Gas stations do not affect the design of new cars.

What is the optimal team for manipulating the conditions of learning? In the hypothetical example above of the closed-circuit television producer, the success of the series will depend on the quality of the relationship he can establish with the TV teacher (if there is one -- TV teachers should not be assumed) and also the classroom teachers. Teamwork between producer and classroom teachers is clearly easier in the highly localized Chicago cluster-school TV system (e.g., Richard Byrd Elementary School) than in WNYE which programs for all New York City schools. The real complexity of the problems facing the educational technologist is caused by the highly fragmented, highly decentralized nature of decision-making in education. The manipulators of the same conditions of learning may be separated by miles and never meet at all. The problem is discussed more

fully under MEDIA ORGANIZATION. One thing is certain: a creative relationship has to evolve between the artist, who is traditionally individualistic, and other members of the team such as classroom teachers, behavioral psychologists, and measurement experts. For really dynamic television, form and content must be born together. The challenge of instructional television is that for many subjects, especially at college level, form and content have to be two different people.

It is too often assumed that there is only one way of combining the variables -- the various media, time, space, etc. -- to reach the objectives. Systems analysis in education promises experimentation with different combinations to achieve the same objective. The essense of systems analysis is generating alternative models. Education is strongly resistant to this kind of competition. ETV stations have carefully avoided competing with the educational establishment. When, and if, the financial base of the stations is strengthened, today's necessary political attitude may not prove quite so necessary.

One of the more tedious aspects of educational technology's confrontation with the traditional classroom is the amount of time and print devoted to assuring all concerned that "Nothing will ever replace the teacher." If this is true, then educational technology may as well surrender. The whole point of the newer media is to do things which the live teacher (for a number of reasons) is unable to do. In industry there is something called offensive research -- research oriented towards making existing company products obsolete. Education and educational technology

could do with some offensive research plus an admixture of competition which is so lauded in the rest of American society.

* * *

MEASUREMENT

Question A: Is measurement necessary?

Technology in its industrial application is tightly bound up with measurement. Measurement is at the heart of systems analysis. But educational technology may reject measurement in certain areas or, at least, make a much more sensitive use of it. There is a real danger when applying industrial techniques to education that we rush headlong into measurement and quantification without asking why. Measurement in education should be scrutinized and not assumed. As we know from Heisenberg in physics, the act of measurement disturbs the subject being measured. This disturbance may, especially on the arts and humanities side, prove to be unacceptable. Measurement is clearly involved in the educational process but it should not be allowed to dominate. Under the impact of an aggressive educational technology, this might happen. The trend away from exams amongst the Unstructured pioneers and the intense frustration of teachers and students with the grades system should not be lightly dismissed. Some educational technologists are so infatuated with the possibilities of measurement that the system they envisage turns out to be more authoritarian, more linear, more tedious, than the worst system is today:

> "As the student enters the school and takes the achievement and aptitude tests, the tests are scored and then the school psychologist examines the results and makes his recommendations as to the degree of reinforcement and the orientation or instructional methodology most apt to be successful with the particular individual. These test results and the psychometrist's recommendations are immediately acted upon by the school psychologist who specifies the student's counselor, subject matter teachers, carrel and initial program(s). The materials center and teaching staff (administrative heads at this point) operating within the guidelines provided by the administration and societal needs allow the school counselor to make this initial schedule." 8/

This "analysis" should be shown to anyone who cannot understand why faculty remain more than sceptical about the applications of technology to the educational process.

Measurement has a big function in education as it is today, and the discovery of really creative measurement people should have high priority. Educational measurement tends to be gross and insensitive. It reveals little or nothing about which instructional strategy is better, about how different sorts of audience participation improve learning by television. Measurement basically says that this student is "better" than that one but we are not sure why. Gross comparisons between television and conventional instruction have not yielded any very valuable data to help us with the following questions:

> Why and when to use television as opposed to live teachers?
>
> Which students gain more from TV than live instruction and vice versa?
>
> What way can telelessons be improved to make for more effective communication?

Media orchestration is going to depend on this sort of evidence. Otherwise choice of medium will continue to have more to do with the bias of persons concerned than with any requirements stemming from the conditions of learning and the students themselves.

Some television people talk loud and long about each medium's having its own special qualities. This is true but it camouflages the fact that media are far more interchangeable than has been imagined. It would have been nice and comfortable if there was no overlap between the media and thus no cause for media hostilities. What has to be established by measurement is the amount of uniqueness and the amount of overlap each of the media possesses. Faced with the fact that both medium a and medium x are equally suited to performing this instructional task, then the choice may end up being an economic one -- which is cheaper? If such a stage as this could ever be reached, radio would blossom again!

Question B: What sorts of measurement?

Pre-testing and evaluation

This measurement is important before the full implementation of an instructional strategy. How do we know that our manipulation of the conditions of learning is going to work? Will this radio series as designed be effective in teaching nurses principles of old-age care?

There has been very little pre-testing of any of the new media, except for some programmed texts. Television people are resistant to "wasting" any money on anything other than production. Pre-testing is expensive and will demand more cooperative regional production if it is

to be feasible. Pre-testing must be used selectively. It will not be needed with a series of lectures by Hermann Bondi on gravitation. It should be used in a course for policeman on knowledge of the law. This kind of measurement has the great value of putting hunches and intuition periodically to the test. Broadcasters can become very isolated from their audience without knowing it. Pre-testing makes you question that audience, think about vocabulary and reading level, pace and sequencing decisions.

The television mistake is to rely on colleagues' evaluation. It can be taken for granted that those colleagues are only rarely a representative sample of the target audience. Pre-testing techniques for the newer media need more development. At the moment they resemble Stone Age Man's big club. Instructional television must question whether the production techniques and studio design which have been taken over without hesitation from commercial television are suited to the requirements of pre-testing.

Diagnostic testing

Diagnostic testing is playing a prominent part in the move towards individualization of teaching strategies. The Oakleaf School in Pittsburgh uses an individualized math course consisting of over 400 sequential objectives; it is vital to know where the student is, to start him at the right point. This problem is not so urgent with group-prescribed instruction. Diagnostic testing will help the teacher, in her new role as classroom manager, in putting the right child in contact with the right

materials at the right time. To the educational technologist, diagnostic testing is important for the collecting of Category I data on students' characteristics. Communication starts with an awareness of the audience. Too often this stage is left out.

Criterion-referenced testing

Here instructional materials and strategies are internally, as opposed to externally, validated: What percentage of all the objectives set up for the particular course were reached by the students? Instructional materials are here judged by the degree to which they attain their own objectives. This may be a more fruitful sort of measurement than the usual normative testing.

It is a reaction against the rather sterile comparisons between television and conventional instruction which, as was said above, have not revealed much useful data. A French course is measured against x,y,z objectives which are its own stated goals, and not against another French course which, more than likely, does not have the same ones. One of the problems with media comparison studies is that the live teacher does some things better, television other things. By comparing them, these cancel each other out and reveal no significant difference. But if we measure the live teacher by his ability to achieve those objectives which may be unique to the teacher medium, then progress is being made.

Unobtrusive tests

The ideal testing situation would presumably be reached when testing and learning merge into each other. This is happening with CAI where

complete records of the student's interaction are kept for analysis. In the freer learning environment, materials would be measured by their degree of popularity. People such as Richard Spencer at Illinois are developing course-evaluation questionnaires which are for student use. There are hopeful signs that the subjective comments of the students are quite a good (unobtrusive) measure of the actual course effectiveness.

Cost measurement

There are two types of cost measurement: cost measurement pure and simple, and cost measurement in relation to effectiveness. The cost of music education for 5th graders in x school district can be measured even though there may be no desire to measure effectiveness. Cost-effectiveness should not be used indiscriminately in education.

Cost analyses would help to focus educational technology. When IBM says it can provide CAI for $1.00 per student-contact hour, it is talking a language almost totally foreign to education. Costing in education has tended to be as gross as many other forms of measurement. But it would be a great step forward if some elementary costing came into the classroom: what are the costs of teaching reading in 2nd grade? What are the costs of a freshman general science course? Such costing is complex because it requires splitting up teachers' salaries, materials costs, heating and electricity, space usage, and -- at college level -- separating out the closely knit strands of teaching and research. At the moment the real cost of television instruction is lost in the fog. Yet without this costing, it seems difficult to know how a university administration can make any rational decisions about its future.

Another advantage of costing is that it will make technologists and educators in general much more committed to getting mileage out of existing equipment and space. NBC can tell you how many dollars it costs to have studios unused. What university closed-circuit systems could do the same? Schools already have, tucked away in parts of the building, many pieces of equipment which are under-utilized. Yet they complain that they do not have the media available to individualize as they would like to. The transmission powers of ETV stations remain unused two-thirds of the week[9/] at a time when society needs more and more information movement.

Machinery in any form is money. Educational technologists cannot afford to be sloppy about costing procedures. Television people complain bitterly about shortage of money. But much money has been spent on television and is sitting around the country in the form of unused or underused cameras, studios, coaxial cable (see for example Indiana University, Great Neck Public Schools, Oral Roberts University, etc.). It is not so much shortage of money as very poor allocation of resources. As we move into the era of computer-assisted instruction, dial access, and computerized information retrieval, cost analyses must become part of the process.

The Programming-Planning-Budgeting System (PPBS) which rose to fame under MacNamara and Hitch in the Defense Department has potential application for education. Big-city school systems like Washington, D.C. are already thinking about it. It involves a deep analysis of decision-

making procedures to see what information needs collecting in what form to facilitate that decision-making. PPBS is a systematic way of relating resources available (e.g., dollars) to objectives desired. It is a way of getting maximum competition of ideas in the search for the best solution to a problem.

Traditionally, the budgeting aspects of a system have been isolated. PPBS bring the budgeting problem back on stage. Traditional budgets list objects of expenditure -- television maintenance, teachers' salaries, telephone bills. Under PPBS the aim is to list objectives of expenditure -- remedial reading, 11th grade Chemistry, beginner's French. It is then possible to see what resources are going where, whether the right balance is being achieved, and -- in the long term -- generating more efficient ways of teaching reading (cost/effectiveness). This sort of budgeting will be a direct help to the television and radio enthusiasts. It will be possible to demonstrate what particular contribution and at what cost per student the radio series is making to any designated program objective. At the moment this cannot be done with much objectivity.

PPBS is the kind of technique that makes it possible to look at the total system. It is one of the best examples of the global thinking described at the beginning of the paper. Because of its complexity, the introduction of PPBS into education lies in the future. But the way of thinking it embodies can permeate the approach of the educational technologist now.

* * *

MEDIA ORGANIZATION

The ultimate success of the four-part process called educational technology will depend on the types of organization that are created to implement it. How can the necessary cohesion be given to the varied problems of production, storage, access to resources, evaluation, distribution, and utilization? For example, the high quality production of a schools radio series does not automatically ensure its utilization. How can we integrate the traditionally isolated decisions made by curriculum supervisors, librarians, film-makers, textbook selectors, school architects, audio-visual coordinators, and budget managers? In the past these decisions have been made by separate and semi-autonomous units without much attention being paid to the wider context or other units whose decisions overlap/ duplicate.

The problem of media organization is encountered in the arrangement of a university, the administration of the school library, the storage and retrieval of nonprint materials, the size of materials-production centers, state and regional networks. The type of administrative structure radically affects the decisions and actions made within it. For example, the unpleasant question needs asking: is the present pattern of local stations compatible with good quality ITV production? The Carnegie Commission envisages in ten years 380 local ETV stations, of which over 200 will have production facilities of varying kinds. Are there 200 film editors available -- given the call of commercial TV and films, and also the closed-circuit systems? Is not the present poor quality of

ITV programs related to the lack of shared and centralized resources? Why has EEN, the model regional network, produced only one series for schools on a regional/cooperative basis? Are local stations compatible with the move towards regional production centers for newer media, advocated by people like C. R. Carpenter?

At university level many of the problems of closed-circuit television can be traced to a weak organizational structure. Television grew up by itself -- cut off from the audio-visual services, the behaviorists interested in programmed instruction, the measurement people, and, of course, the library. The closed-circuit system had one aim: to get closed circuit used. If a professor wanted help, that help was predetermined to take the form of closed-circuit television. It is not therefore a surprise that television has not grown beyond rather elementary uses in a small percentage of courses. The educational process is far too complex to be adjusted by one medium, however valiant.

Today there is a trend to remedy the unhelpful categorizations of the past by moving towards some kind of integrated media structure. Michigan State University, Northeastern University in Boston, University of Illinois, University of Wisconsin are front-runners in this move. The new structures usually include television and radio (closed and open), audio-visual services (including film-making), measurement, and a very small group of behaviorists.

Unfortunately, the integration hasn't gone far enough. The fast-growing computer centers, which often include CAI projects, are

not connected (see University of Illinois). More importantly, the library is still administered separately. As the library gets more involved with technology, this fragmentation will prove as anomalous as that between television and audio-visual. The new media structure often fails to have close links with the architectural and design people, with the result that new buildings are still going up without even the most obvious needs of educational technology allowed for (enough power points, lighting arrangement, etc.).

In the search for the best way of organizing media for a given problem it may be useful to look at education as a communications process and the educational institution as an information system. We are beginning to think about the modern library, for example, not as a pile of bricks and bindings but as information movement. The new information sciences have a big contribution to make to educational technology. Information and its handling are becoming the largest functions of a technological society. Thus we can ask the following kinds of questions in the design of media organization:

What information needs to be transmitted?

What and how is it stored?

What format should the information being transmitted take?

To what points/people should it be transmitted? At what speed?

What is best distribution device for transmission? How can 'noise' be reduced?

What type of access to information is required? At what speed?

These sorts of questions will help us solve educational communications problems at many levels of complexity. If this type of question had been asked in the Daly City, California, elementary school involved with the EBF/Bell and Howell $600,000 Discovery Project, then the first thing to enter the classroom would not have been a 16 mm projector but acoustic carpeting.

Educational technology faces overwhelming problems of accessibility and these kinds of questions will improve the chances of finding solutions. The television producer has problems of access to visual material. What central libraries of film footage, slides, stills exist and how should they be expanded? How should nonprint materials be indexed? What types of access does the producer have to the library? Heaps of visual material wait to be used but are unknown, un-indexed, uncoordinated, or lost in the quicksands of copyright. Television and radio also face the problem of access to research data on audio-visual communication. Where is the data stored? How can it be made most accessible? How can research conclusions be rewritten so that directors understand them? These questions are being asked by ERIC, the Educational Research Information Center at the Office of Education. This is the kind of way that the science of learning can creep into the busy TV control room.

The audiovisual coordinator and the classroom teacher have problems of access to films, audiotapes, videotapes, slides. Poor accessibility radically lowers usage and interest. Libraries like the National Center for School and College Television, the National Center for Audio Tapes at Boulder, Colorado, and the National Medical Audiovisual Center at Atlanta

are making an impact but much greater expansion and resources are needed. The McGraw-Hill NICEM project with the University of Southern California, which is cataloguing via computer all available educational media, is having troubles. Today's school administrator who has the task of purchasing educational hardware and software is being swamped by the quantity of firms and conflicting claims. Brochures, unscrupulous salesmen, "statistics," and gratuitous advice descend on him and he probably does not know a videotape recorder from a correlation coefficient. To help him, Educational Products Information Exchange in New York City is trying to do consumers' reports on educational media.

The most important asset that any media organization can have -- whether it be a television station, an instructional resources center, or a state education department videotape library -- is flexibility. Educational technology is changing faster than the media organizations. Media organizations should be busy diversifying and merging; instead too many sit still and say "Well, we are broadcasters, that's our job." WGBH is one of the few educational stations that has seen the writing on the wall and is busy in its Education Division investigating other aspects of telecommunications and educational media. The CBS EVR device may alter considerably traditional patterns of production/distribution. What is the best organization for production purposes may not be best for distribution.

There are many pressures which make media organizations inflexible and unwilling to diversify. One very strong pressure comes from the

multitude of national associations which are set up to push their own particular medium. The dilemma facing NAEB is that they are talking about educational technology but their survival depends on local ground-based television and radio stations. The pull of the technology may be towards a grid system of regional media centers but the pull of the association is towards as many local stations as possible. The media hostilities, for example between television and audio-visual, are real barriers in the path of media equality and integration. The rechristening of DAVI is a step in the right direction. Media organizations that look integrated are often less so on close examination. The same mentalities are there but under different names.

A study of educational technology should devote much time to the study of the various types of media organization and come up with guidelines. What media organizations exist/are needed to solve the problems of:

Production quality?

Storage and good retrieval/distribution?

Utilization?

Evaluation?

An interlocking system of local/regional/national centers needs developing which can swiftly upgrade the quality of production, distribution, and usage of "instructional television and radio. . . instructional materials such as videotapes, films, discs, computers, and other educational materials or devices."

A media organization, at university level, ought to contain as many of the following elements as the size and character of the institution warrant:

Television
- Closed and open circuit

Radio

Audio-visual
- Service and production aspects

Library

Computer center
- CAI projects

Behavioral psychologists
- To work in teams with TV, audio-visual, measurement, innovation strategists, in the manipulation of conditions of learning with the subject matter experts.
- To develop programmed instruction in print, film, computer media.
- To run research-and-development activities. Basic research should be going on besides applied work if only for prestige reasons vis-a-vis faculty.

Measurement team

Innovation strategists
- To guide implementation of new projects. Innovation strategy has been neglected in the past.

Training unit
- For technologists themselves
- For faculty

Close links with budgeting office, involved with PPBS techniques

Close links to new building projects

Close links to department heads and faculty

Operations-research unit
- Developing PPBS/systems analysis techniques
- Special brief to keep media organization flexible and responsive to changing conditions

One of the key problems facing the media organization at university level is establishing relationships with the department heads who make the curricular decisions and the faculty who need time, encouragement, and assistance. This is a delicate problem. At Michigan State, the Educational Development Program reports directly to the provost and EDP's director has his office a few doors from the provost. When department heads come to the provost with an instructional problem, it can easily be passed to EDP for scrutiny. The Educational Communications Division at the University of Wisconsin reports to the head of Extension which is less favorable in terms of contact with the main university departments.

Another problem, related to this, is the degree of centralization. In a large university, decisions are made at various levels and at various distances from the center. A challenging task facing the educational technologist is how to balance enough decentralization to get faculty involvement and enough centralization to get the full benefits of technology (critical mass factor). At Ohio State University a mini-media organization has developed in the chemistry department because the chemists considered the central organization (Telecommunications Center) too distant and too cumbersome. This problem of centralization/decentralization rears up in the discussion of optimal sizes for closed-circuit systems, the relationship between local stations and national/regional networks and libraries. The pros and cons of centralization and decentralization have to be carefully weighed.

The question facing any media organization in its attempt to implement educational technology is: who should make what decision at which point in the process? The decision by the administration not to permit (for financial or other reasons) free time for teachers to preview films, work on objectives, develop strategies, on a regular basis, clearly affects the speed with which educational technology can be introduced. Educational technology is a technique by which the decision-making procedures of a whole system can be scrutinized and ordered. As with systems analysis in other fields "the objective is to sharpen intuition and judgment."[10/]

* * *

A PERSONAL OPINION

This paper has described the major direction which a study of educational technology should in my opinion take. A summary of these directions -- in question form -- will be found at the end. Before this summary I would like to append my own more personal feeling about the role of the new media -- particularly radio and television. Educational technology is, I feel, the asking of the right questions. Here are some brief subjective answers to one or two of them.

Freedom

The most challenging function of educational technology is to liberate teacher and student. Technology, correctly and creatively applied, should

enable the kinds of freedom in education which have often been dreamt of, but have only rarely found reality. Group-paced and group-prescribed instruction was a virtual necessity when the educational media available were restricted to live teacher and books. Individual differences had to be put to one side in any normal system with average teacher/student ratio.

But with the sudden blossoming of many different ways that students can interact with subject matter and with (not necessarily live) teachers, these individual differences can be taken seriously. The built-in monopolies of education are destroyed. The rigidity of what students learn, how they learn, when and at what pace, is no longer necessary. One teacher and textbook per thirty students are no longer the only solutions. New combinations of teachers, students, materials, space and time, can be dictated more by the existence of educational needs, and less by the absence of appropriate instrumentation. The live lecture as the medium of college undergraduate education can now be seriously questioned.

A new freedom in education is necessary if only because of the world beyond the classroom walls. The sort of society into which today's first-grader will step after high school is not known. Change is the only constant, and the educator can no longer be sure at all that he knows "what is good for the child." The sensitive use of technology in education will increase the alternatives, and will allow the student to find his own direction more easily. He can be surrounded by a richer store of experiences and realities. This store can be organized on

modular lines so that he can combine the various units to his own specifications. (This same modular freedom must be given to the teacher so that she can have the choice of complete courses or single units according to need. Closed-circuit TV has been obsessed with complete courses to the exclusion of providing individual units of vivid interest on the modular system.)

Educational technology -- by analogy to the cafeteria studies -- is able to place the student in the midst of a balanced diet of knowledge and exploration. Some of the units will be programmed behaviorally, others will remain much looser and less systematic. Thus self-direction, seldom achieved (I think actually inhibited) by traditional group methods, may become an attainable objective. This self-direction is indispensable in a world which has prospects of increased leisure and has demands now for nonstop learning through life.

Freedom has always been stated as a goal of education in a democratic society. But the only real training for freedom is the practice of it, rather than preaching about it. Technology makes this freedom more attainable. It liberates the individual from the group. Education is an intensely personal affair.

First-hand knowledge

Many years ago, Whitehead wrote: ". . . we must rise above the exclusive association of learning with book-learning. First-hand knowledge is the ultimate basis of intellectual life. To a large extent

book-learning conveys second-hand information, and as such can never rise to the importance of immediate practice. Our goal is to see the immediate events of our lives as instances of our general ideas. What the learned world tends to offer is one second-hand scrap of information illustrating ideas derived from another second-hand scrap of information. The second-handedness of the learned world is the secret of its mediocrity."[11]

Via educational technology, the student can encounter something nearer to first-hand knowledge than is customary. He no longer has to just read about the flora and fauna of Brazil, he can "see" it. The television can transport Brazil in two dimensions, the museum in three dimensions. Traditional education is one long intervention between the learner and the subject to be learned. Television has the power to bring the student face to face with reality as it unfolds. But more and more ITV series are canned and rented from libraries. Radio can go anywhere very fast and very economically and confront the student with the demonstrator himself, with the poor people's leaders at Resurrection City, with explorers in the Antarctic. Instead schools radio records some woman reading stories from a book about George Washington.

Knowledge and reality are too often needlessly filtered by textbooks and teachers so that by the time they reach the student they are predigested conclusions, neatly packaged, with complete multiple-choice tests, and thoroughly divorced from the "radically, untidy, ill-adjusted character" (also Whitehead) of reality. Schools television should dominate along

with radio the teaching of current affairs in American schools -- but they don't. Most of TV time is spent watching another teacher talking about something that is not shown.

If we had stopped to think more about the unique qualities of the medium, educational television and radio stations would behave less like canning factories. All schools programs are planned and committed a year in advance thus destroying the main benefit of the medium (over, say, film) -- spontaneity. It is sad to think that those working in games theory and simulation are doing more to offer students an encounter with reality than live broadcasting. This is one more example where television and radio are being bypassed by other media. Education is the exploration by man of his environment. Educational technology has the exciting opportunity to help create that environment in and around the school, so that the student can explore it, manipulate it, and learn to accommodate himself to it. The newer media can ensure that this simulated environment is not too abstract.

Equality

Nearly all classrooms in America can have the luxury of hearing and/or seeing Sir Laurence Olivier play Othello. The cause of equality of educational opportunity can be furthered by educational technology. When the telecommunications network envisaged by EDUCOM is operational, the small college in the boondocks can have direct access to the greatest libraries in the country. At the moment, via the National Library of Medecine's MEDLARS system, doctors in Denver can get as much up-to-date

bibliographic information on recent medical literature as doctors living near the central computer in Bethesda.

Why should the college student in Alabama not be able to see lectures by Commager at Amherst? This has been technically feasible for years. The dream of master teachers via TV -- much talked of in the 50's -- has never been realized. It has ended up with compromise candidates picked by the local establishment for local use. Great Plains is distributing college courses not by Gerald Holton at Harvard or Postlethwait at Purdue, but by faculty of Chicago City College. The promise is still there. Technology does not have to move people, it moves the effects of people. The limits placed on this movement are political, parochial, financial -- not technological. Equality in education -- by which I mean access to equally rich learning environments -- is not possible in a country devoted to mass universal education without recourse to technology.

Relevance

The disadvantage of books and films is that schools (and students) have to use them for at least five years to get back the investment. But TV , radio, and the xerox copier are in the front line of events. They can be the shock troops in the conquest of irrelevance in education. The challenge facing radio and TV is relating what is happening now to the classroom. Radio and television can make regular trips to the frontiers of science so that the high school physics student can identify with the bigger picture. The great quality of tape (audio and video) is that it

can be erased and used again. It can thus make a dynamic -- rather than static -- curriculum. The xerox copier makes instant textbooks. Vietnam, civil rights, air pollution, famine in Asia are too often evaded in school. Technology can help to dynamite curriculum guides at regular intervals.

Creativity

Most of the latent creativity in students has to be expressed in writing essays, painting, making speeches. But the media of creativity outside the classroom are far broader. Educational technology should be moving towards the day when one student hands in an 8mm film on "Spring", another an essay, and a third a sound documentary. Screen education demands a place in school unless it is believed that television and film are still not as influential in modern society as the poem and short story.

The museum project at Berkeley, EPOCH, is a good example of the use of the new media to develop creativity. With the use of slides, discs, films, tapes, 3-D objects, whole environments are created around the student in a special circular chamber. It may be a scene from Bangkok, Thailand, or the four walls of a pharaoh's tomb, or a mix of Art Nouveau and modern psychedelic art.

Once the principle of media equality has been accepted, and the present restrictions have been lifted on what constitutes art at school, a far higher level of creativity amongst all students will, I believe, be discovered. The creativity of the teachers themselves can be enormously stimulated by the multimedia lecture halls as at University of Wisconsin.

Much of education is concerned with the different faces of perception, the different dimensions of reality. These dimensions cannot be squeezed into print, mathematical symbols, or the teacher's voice. The multi-sensory quality of a modern urban environoment should not be stunted in the classrooms.

A replicable system

Educational technology's ultimate goal should be the creation of systems of education that are replicable, and that are relevant to the needs of mass universal education. In the design of these systems, a majority of good teachers cannot be assumed: in Washington, D. C. during 1966-7, 45.1% of teachers were temporary.

America's lasting contribution to the underdeveloped world will not be teacher-training colleges, but a science of education. Educational technology is the way we engineer and instrument that science. How do we get good education to those students not lucky enough to have good teachers? That is the question facing the educational technologist. By the year 2000 there will be 6 billion people living on this planet. Population growth since the 1950s has led to an increase in the aggregate number of adult illiterates living in the world.

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SUMMARY

Educational philosophy

What are the priorities of American education?

Science of learning and communication

What are the trends in the way American education is organized?

What scientific data can be brought to bear on the design of the educational environment and on the improvement of educational communications?

Educational technology

How do we define it?

Educational media

What are all the available media in education? No discrimination.

What sort of data can be compiled, characterizing each of the above media?

Educational technology: a four-part process

Objectives formulation: Who should select objectives?
Should there be objectives at all?
What input data should be collected to assist in formulation?
What constitutes "good" objectives?

Identification of types of learning

Manipulation of conditions of learning
What are the constraints within which strategies must be devised to reach objectives?

Who should manipulate the conditions of learning?

Measurement
Is measurement necessary?

What sorts of measurement?

Media organization

How do we organize educational media to implement educational technology?

How do we integrate media and curricular decisions?

How centralized/decentralized should media organizations be?

What media organizations exist/are needed to solve the problems of:

Production and quality?
Storage and good retrieval/distribution?
Utilization and evaluation?

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